

# PATENT COOPERATION TREATY

## PCT

### INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

REC'D 16 JUN 2005

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Applicant's or agent's file reference WO 800320-MP/co	<b>FOR FURTHER ACTION</b> See Form PCT/PEA/416	
International application No. PCT/NL2004/000197	International filing date (day/month/year) 22.03.2004	Priority date (day/month/year) 21.03.2003
International Patent Classification (IPC) or national classification and IPC B81C1/00		
Applicant TECHNISCHE UNIVERSITEIT DELFT et al.		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

3. This report is also accompanied by ANNEXES, comprising:

a. ☒ sent to the applicant and to the International Bureau) a total of 4 sheets, as follows:

☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).

☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.

b. ☐ (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

☒ Box No. I Basis of the opinion

☐ Box No. II Priority

☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability


☐ Box No. IV Lack of unity of invention

☒ Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

☐ Box No. VI Certain documents cited

☐ Box No. VII Certain defects in the international application

☐ Box No. VIII Certain observations on the international application

Date of submission of the demand 20.10.2004	Date of completion of this report 14.06.2005
Name and mailing address of the international preliminary examining authority:  European Patent Office - Gitschiner Str. 103 D-10958 Berlin Tel. +49 30 25901 - 0 Fax: +49 30 25901 - 840	Authorized Officer  Polesello, P  Telephone No. +49 30 25901-757



**INTERNATIONAL PRELIMINARY REPORT  
ON PATENTABILITY**

International application No.  
PCT/NL2004/000197

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**Box No. I Basis of the report**

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1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☒ This report is based on translations from the original language into the following language english, which is the language of a translation furnished for the purposes of:
- ☒ international search (under Rules 12.3 and 23.1(b))
  - ☐ publication of the international application (under Rule 12.4)
  - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the **elements\*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

**Description, Pages**

1-15 as originally filed

**Claims, Numbers**

1-26 received on 25.01.2005 with letter of 21.01.2005

**Drawings, Sheets**

1/9-9/9 as originally filed

☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/figs
- ☐ the sequence listing (*specify*):
- ☐ any table(s) related to sequence listing (*specify*):

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/figs
- ☐ the sequence listing (*specify*):
- ☐ any table(s) related to sequence listing (*specify*):

\* If item 4 applies, some or all of these sheets may be marked "superseded."

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**Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

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**1. Statement**

Novelty (N)	Yes: Claims	1-26
	No: Claims	
Inventive step (IS)	Yes: Claims	1-26
	No: Claims	
Industrial applicability (IA)	Yes: Claims	1-26
	No: Claims	

**2. Citations and explanations (Rule 70.7):**

**see separate sheet**

**Re Item V**

**Reasoned statement with regard to novelty, inventive step or industrial applicability;  
citations and explanations supporting such statement**

Reference is made to the following document:

D1: PATENT ABSTRACTS OF JAPAN vol. 2002, no. 12, 12 December 2002 (2002-12-12) -& JP 2002 244053 A (SONY CORP), 28 August 2002 (2002-08-28)

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Document D1, which is considered to represent the most relevant state of the art, discloses (cf. figure 2) a method for the fabrication of a membrane from which the subject-matter of claim 1 differs in that the through-opening is formed in the membrane oriented in the (111) plane only.  
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The subject-matter of claim 1 is therefore new (Article 33(2) PCT).

The problem to be solved by the present invention may be regarded as structuring the membrane alone in order to use it as a base for cantilevers, filters, etc..

The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT) for the following reasons:  
in D1 the structure oriented in the (111) plane is actually a hinge for a micromirror ((12) in figure 1). Therefore having an opening also in the (100) plane allows to lighten said hinge. This goes away from the teaching of the present invention where the membrane has other applications.

Claims 2 to 9, 23 to 26 are dependent on claim 1 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

Claim 10 is a membrane obtained by a method according to one of the claim 1 to 9. As the difference between claim 1 and the document D1 is actually a product feature (an opening in the membrane only), claim 10 is new and inventive with respect to D1, too (Articles 33(2) and 33(3) PCT).

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Claims 11 to 22 are applications of the membrane according to claim 10. Therefore claims 11 to 22 are new and inventive, too (Articles 33(2) and 33(3) PCT).

Claims 1 to 26 satisfy the requirements of Article 33(4) PCT with respect to industrial applicability.

25. 01. 2005

(93)

Amended claims

1. A method for the fabrication of a membrane (2) oriented in a (111) plane of a (100) silicon wafer (1), comprising the steps of:

- applying a masking layer (3) to both sides of the wafer (1), wherein portions (4) of the sides are covered by the masking layer (3); and

- the at least partial removal by etching away silicon material from the portions (5) of the two sides of the wafer (1) that are not covered,

~~characterised in that:~~

- wherein the etching step substantially removes the silicon material forming recesses (6, 7) in the two surfaces of the wafer (1), such that the walls (8, 9, 10, 11) of the recesses (6, 7) are formed by (111) planes,

- wherein not covered portions at both sides of the wafer are aligned in relation to one another such that a (111) plane (9 or 10) formed from a first side is oriented parallel to a (111) plane (10 or 9) formed from a second side, and the distance d between said two planes (9, 10) is less than the thickness of the silicon wafer (1), so as to form a membrane (2) in the (111) plane having a thickness d, and

characterised in that:

- at least one through-opening (12) is formed by an etching treatment in the membrane (2) oriented in the (111) plane only, with the opening (12) being oriented substantially perpendicularly in relation to the (111) plane (9, 10).

2. A method according to claim 1, **characterised** in that into both sides of the wafer (2) V-shaped recesses (6, 7) are etched, wherein the lowest point in a V-shaped recess (6, 7) in a first side is positioned adjacent to a not covered portion (5) at the other side of the wafer (1).

3. A method according to one of the preceding claims, **characterised** in that a recess (6, 7) in a first side reaches up to the masking layer (3) at the second side.

4. A method according to one of the preceding claims, **characterised** in that the thickness  $d$  is measured and the etching step is continued to etch the (111) planes (8, 9, 10, 11) until a desired thickness  $d$  is attained.

5 5. A method according to one of the preceding claims, **characterised** in that after the completion of the etching step the masking layer (3) is removed.

6. A method according to one of the preceding claims, **characterised** in that said step comprises providing an  
10 longitudinal opening (12) that extends through the membrane (2) formed in the (111) plane, wherein the opening (12) extends from the free end (13) of the membrane (2) into the direction of a position (Z) where the membrane (2) is attached to the wafer (1).

15 7. A method according to one of the preceding claims, **characterised** in that the through-opening (12) is formed by an etching treatment, preferably by means of a dry-etching treatment, preferably a plasma etching treatment.

8. A method according to one of the claims 1 to 6,  
20 **characterised** in that the through-opening (12) is formed by radiation with a high-energy source.

9. A method according to one of the preceding claims, **characterised** in that at least two parallel ~~cuts~~ longitudinal openings (12) are formed, oriented substantially perpendicular  
25 in relation to the line where the formed membrane (2) is attached to the wafer (1), so as to form at least one cantilever (14).

10. A membrane (2) obtained by a method according to one of the claims 1 to 9.

30 11. An application of a membrane according to claim 10 in a scanning element of a scanning element microscope, scanning probe microscope, or a friction force microscope.

12. An application of a membrane according to claim 10 in a mirror.

35 13. An application of a membrane according to claim 10, wherein a first surface of the (111) plane forms a reflecting

surface and the other surface comprises a position-modifying means.

14. An application of a membrane according to claim 10 in a microgrip, by positioning two membranes in a V-shape such that their ends (13) are oriented towards a mutual point of intersection (S) and are placed at a distance from one another.

15. An application of a membrane according to claim 10 in a filter system, and provided with at least one opening (12).

16. An application according to claim 15, wherein at least one side of the wafer (1) is covered with a mask (15), wherein the recesses (6, 7) formed at both sides of the membrane (2) are in communication by means of the at least one opening (12).

17. An application of at least two membranes (2, 2') according to claim 10 arranged in a V-form in a positioning means (18), wherein at least one side of at least one of the membranes (2, 2') is provided with an actuator layer (22) for actuating the at least one membrane (2 or 2'), to allow an object on the membranes (2, 2') to be positioned in a predetermined manner.

18. An application of a membrane according to claim 10 in a microgripper as pick-and-place mechanism, for picking up objects to be handled, for manipulating and for moving them.

19. An application of a membrane according to claim 10, of which at least one surface is provided with a sensor layer (22), in a (bio)chemical sensor.

20. An application of a membrane according to claim 10 in a fuel cell, wherein on the membrane a first electrode is formed, electrically separated from a second electrode by an intermediate layer, and provided with openings to allow fuel to move from an outside of the first electrode to an outside of the second electrode.

21. An application according to claim 20, wherein the membrane is removed.

22. An application according to claim 20 or 21, wherein the intermediate layer is selected from the group comprising



an electrolyte, for example, a solid oxide, a solid polymer, or a proton exchange membrane and a catalyst.

23. A method according to claims 1-9, **characterised** in that after the membrane (2) has been formed with thickness d, a layer (16) is applied of a material that exhibits a different etching behaviour than silicon, whereafter the silicon material is at least partly etched away.

24. A method according to claim 23, **characterised** in that the layer (16) of the material is applied over at least a portion of the silicon membrane's (2) surface.

25. A method according to claim 23 or 24, **characterised** in that the material forming the layer (16) is selected from silicon nitride, silicon oxide or silicon carbide.

26. An application of a membrane obtained by the method according to claim 23 or 24, wherein the layer (16) of the material is electrically conductive and has an elongated shape from a first connection point to a second connection point, and forms a heating element, and is connected at the two connecting points to a power source.